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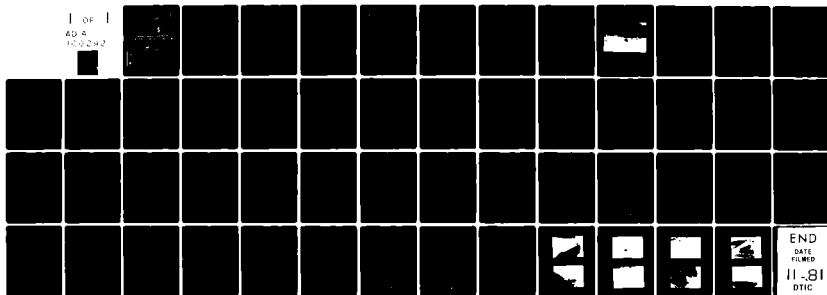
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**RACOLA TAILINGS DAM
WASHINGTON COUNTY, MISSOURI
MO 30475**

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**PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM**



**United States Army
Corps of Engineers**

*...Serving the Army
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St. Louis District

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18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Dam Safety, Lake, Dam Inspection, Private Dams		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.		

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ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 NORTH 12TH STREET
ST. LOUIS, MISSOURI 63101

LMSD-FI

11 December 1979

SUBJECT: Racola Tailings Dam Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Racola Tailings Dam (MO 30475).

It was prepared under the National Program of Inspection of Non-Federal Dams.

This dam has been classified as unsafe, emergency by the St. Louis District because of mining activity at the toe of the downstream embankment slope. Excavation of embankment material has resulted in an excessively steep embankment slope. Mining of the downstream embankment material should cease immediately.

Also, it has been determined that the dam can contain only 32 percent of the Probable Maximum Flood without overtopping and probable failure of the dam with a resultant loss of life downstream. For Phase I reports, the extent of the downstream damage zone has been determined assuming that all materials contained by the tailings dam are in a liquid state. Further investigation would be required to determine the true condition of the materials contained within the tailings pond. These investigations are beyond the scope of a Phase I investigation and are the responsibility of the State or owner.

SIGNED
SUBMITTED BY: _____
Chief, Engineering Division

11 DEC 1979

Date

SIGNED
APPROVED BY: _____
Colonel, CE, District Engineer

11 DEC 1979

Date

RACOLA TAILINGS DAM
WASHINGTON COUNTY, MISSOURI

MISSOURI INVENTORY NO. 30475

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

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INTERNATIONAL ENGINEERING COMPANY, INC.
CONSULTING ENGINEERS
SAN FRANCISCO, CALIFORNIA

UNDER DIRECTION OF
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
FOR
GOVERNOR OF MISSOURI

JULY 1979

PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam	Racola Tailings Dam
State Located	Missouri
County Located	Washington
Stream	Offstream from Old Mines Creek
Date of Inspection	15-16 April 1979

Racola Tailings Dam, I.D. No. 30475, owned by Tom Villmer of Cadet, Mo., was inspected by a civil engineer and an engineering geologist from International Engineering Company, Inc., of San Francisco, California. The purpose of the inspection was to assess the general condition of the dam with respect to safety. The assessment is based upon an evaluation of the available data, a visual inspection, and an evaluation of the hydrology and hydraulics of the site in order to determine if the dam poses hazards to human life or property. The purpose of the dam is to provide impoundment for barite ore tailings. The impoundment is inactive.

Racola Tailings Dam was inspected using the "Recommended Guidelines for Safety Inspection of Dams" furnished by the Department of the Army, Office of the Chief of Engineers. Based on these guidelines, this dam is classified as being of intermediate size. The St. Louis District Corps of Engineers has classified this dam as having high downstream hazard potential. Failure of this dam could threaten life and property. The estimated damage zone provided by the St. Louis District Corps of Engineers extends approximately four and one-half to five miles downstream of the dam. There are 26 dwellings, a schoolhouse, commercial activities and the town of Racola within this damage zone.

The results of the inspection indicate an absence of facilities for discharging flood water, inadequate freeboard, and failure of the dam to meet the criteria given in the guidelines for a structure with the size and hazard potential of Racola Tailings Dam. As an intermediate size dam with a high hazard potential, the Guidelines specify that the discharge capacity and/or storage capacity should be capable of safely handling the Probable Maximum Flood (PMF) without overtopping the crest. The PMF is the flood that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. It was calculated that the impoundment can retain the 100-year flood (a flood having a 1 percent chance of being equalled or exceeded in any 1 year) without overtopping the dam. It was also estimated that the impoundment can retain 32 percent of the PMF without overtopping the crest. However, the impoundment cannot retain 50 percent of the PMF without overtopping the embankment.

The inspection team observed that the present owner is actively mining gravel from the dam crest near the low point of the dam. This has the effect of reducing available freeboard and the dam's ability to retain runoff. This is a serious deficiency which should be corrected immediately.

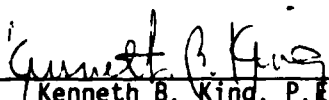
Adequate overflow facilities and freeboard should be provided so that the impoundment can handle the PMF without overtopping the crest and without significant erosion of the embankment.

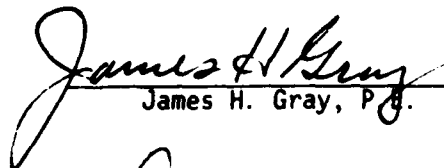
Seepage and stability analyses of this dam are not available. These studies should be performed by a professional engineer experienced in the design and construction of tailings dams and should be made a matter of record. Based on the results of these analyses, remedial measures may become necessary. Remedial work should be done under the direction of an engineer experienced in tailings dam design and construction.

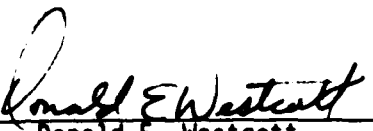
An inspection and maintenance program should be initiated. Periodic inspections should be made and documented by qualified personnel to observe the performance of the dam.

A plan to permanently drain the impoundment and safely reclaim the site could be developed and implemented under the direction of qualified personnel as an alternative to remedial measures recommended for the dam.

It is recommended that the owner take action to correct the deficiencies described.


Kenneth B. King, P.E.


James H. Gray, P.E.


Donald E. Westcott



Overview of Racola Tailings Dam (30475)
from Rt. 21.

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
RACOLA TAILINGS DAM
ID NO. MO 30475

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HYDROLOGIC AND HYDRAULIC ANALYSES

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PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
RACOLA TAILINGS DAM - ID NO. 30475

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority. The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspections of dams throughout the United States. Pursuant to the above, the St. Louis District, Corps of Engineers, District Engineer directed that a safety inspection of the Racola Tailings Dam be made.

b. Purpose of the Inspection. The purpose of the inspection was to assess the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.

c. Evaluation Criteria. Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, in "Recommended Guidelines for Safety Inspection of Dams." These Guidelines were developed with the help of several Federal agencies and many state agencies, professional engineering organizations, and private engineers.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances.

(1) Racola Tailings Dam is an earthfill dam that was used to impound barite ore tailings. The impoundment is formed by a ring dike that closes on a knoll.

(2) There is no active spillway at the dam.

b. Location. The dam is located in Washington County, Missouri, as shown in Plate 1. The dam is shown in Plate 2 and is located in Section 7, Township 38 North, Range 3 East.

c. Size Classification. Racola Tailings Dam is classified as an intermediate size dam in accordance with "Recommended Guidelines for Safety Inspection of Dams".

d. Hazard Classification. This dam is classified as having a high hazard potential by the St. Louis District, Corps of Engineers. The estimated damage zone, as provided by the St. Louis District, Corps of Engineers, extends approximately four and one-half to five miles downstream of the dam. There are 26 dwellings, a schoolhouse, commercial activities, two bridges, and the Town of Racola within this damage zone.

e. Ownership. This dam is owned by:

Tom Villmer
Route 1
Cadet, MO 63630

f. Purpose of Dam. The dam impounds tailings that resulted from a barite separation and beneficiation operation. Tailings are no longer conveyed to the impoundment.

g. Design and Construction History. There is no written design or construction data available for this dam. Information obtained from Mr. Gene Williams, General Superintendent of Dresser Minerals, Inc., indicates that the J. E. Carter Company built the dam in 1953; it was operated until 1969 by Dresser Minerals, Inc. The site is inactive and is being reclaimed for use as farmland by the present owner.

h. Normal Operating Procedures. No operating records are known to exist. Runoff into the pond is removed by seepage into the tailings and by evaporation. The facility is inactive in that tailings are no longer conveyed to the impoundment.

1.3 PERTINENT DATA

a. General. Field surveys were made by Booker Associates, Inc. of St. Louis, MO., on 26 April 1979. Field measurements are valid as of the dates of inspection and survey.

b. Drainage Area. 32 acres (from ASCS air photograph #BMH-3MM-192 dated 8-26-71.)

c. Discharge at Damsite.

(1) Outlet Pipes - Nonfunctional.

(2) Total Spillway Capacity at Maximum Pool Elevation - No spillway for this dam exists.

d. Elevation (Feet above M.S.L.)^{1/}

- (1) Top of Dam (Maximum Pool) - El. 739.5 feet to El. 726.0 feet
- (2) Crest of Maximum Section - El. 736.9 feet.
- (3) Impoundment Level at Date of Survey - 722.0 feet.
- (4) Outlet Pipes (Invert) - 6-inch pipe - Sta. 28+64 - El. 728.0 feet.
8-inch pipe - Sta. 28+95 - El. 730.5 feet.

e. Reservoir.

- (1) Length of Maximum Pool - 1200 feet + (from ASCS airphoto BMH-3MM-192).
- (2) Length of Impoundment Pool - 600 feet + (from ASCS airphoto BMH-3MM-192).

f. Storage Capacity above Tailings Surface - 29 acre-feet.

g. Reservoir Surface Area.

- (1) Top of Dam (Maximum Pool) - 11.6 acres at El 726.0 feet.
- (2) Impoundment Level - 4 acres at El. 722.0 feet.

h. Dam.

- (1) Type - earthfill.
- (2) Length of Crest - 3900 feet \pm .
- (3) Maximum Height of Dam - 78 feet \pm .
- (4) Width of Crest - from 20 feet to about 25 feet.
- (5) Side Slopes -
 - (a) Downstream slope - approximately 1V on 1.5H.
 - (b) Upstream slope - unknown.

^{1/} Elevations are based on reference of 740.00 feet M.S.L. This datum was developed from topographic data presented on the Tiff 7.5-minute Quadrangle Sheet.

- (6) Zoning - The dam appears to be constructed consistent with the prevailing barite dam construction practice. This would consist of a clay starter dam enlarged using -7/8 inch gravels.
- (7) Cutoff - There is no written information available to indicate that a cutoff was designed or constructed.
- i. Spillway. There is no spillway at Racola Tailings Dam.
- j. Outlets. Note that these pipes are considered to be non-functional.
 - (1) Length - 6-inch pipe - 80 feet
8-inch pipe - 110 feet
 - (2) Invert of Pipe at Upstream End 6-inch pipe - El. 728.0 feet.
8-inch pipe - El. 730.5 feet
 - (3) Invert of Pipe at Downstream End - 6-inch pipe - El. 702.0 feet.
8-inch pipe - El. 696.0 feet.
 - (4) Type Circular steel pipes - 8 inches in diameter.
6 inches in diameter.
 - (5) Shape of Entrance - near vertical riser pipes (square edges).
 - (6) Slope - unknown.
 - (7) Flow at Time of Inspection - 6-inch pipe was flowing at approximately 3 gallons per minute. The other pipe was dry.
- k. Diversion Ditches. - Not applicable.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

No design drawings or data are known to exist.

2.2 CONSTRUCTION

a. Information. The dam was built in 1953 by the J. E. Carter Company. There are no records concerning construction methods, materials, or procedures.

b. Assessment of Construction Method and Materials. Procedures used to build this dam were developed by miners using trial and error techniques over the last 60 years. After construction of the starter dam, sand and angular gravels (finer than 7/8 inch) were hauled to the crest of the dam, end-dumped and spread. Excess material was pushed over the upstream and downstream faces of the dam. The height of the embankment was raised anywhere from 1/2 foot to 2 feet for each lift using this technique. The sands and gravels placed in this manner are in a loose state and are at their natural angle of repose on the downstream face. The material pushed over the upstream side rests on the tailings. The center line of the dam remains approximately at the same position as the embankment is raised. Compaction of the material on the crest was by construction equipment.

The 7/8-inch gravels are free draining, angular and relatively well graded through the gravel and coarse sand range. The gravels appear to function well as a drain material and it also functions fairly well to protect against erosion caused by rainfall; however, it is inadequate to prevent erosion from channelized surface flow with a velocity greater than 4 to 6 feet per second.

The procedures generally used to construct the starter dam probably were as follows. The site was cleared and usually stripped. A cutoff trench was excavated with scrapers to variable depth and then back-filled with the residual clay soil. The starter dam was constructed to a height up to 30 feet, and stony clay was used as the fill material. The crest width usually varied from 15 to 25 feet; side slopes could vary from 1V on 1H to 1V on 2H.

Foundation preparation for the downstream foundation zone appears to be nonexistent, as buried trees in the downstream face tend to indicate.

2.3 OPERATION

The impoundment was operated from 1953 by J. E. Carter and subsequently by Dresser Minerals, Inc. until 1969. No records of operation are known to exist.

2.4 EVALUATION

a. Availability. No design or construction records were available. The only information made available to the inspection team was provided during conversations with the owner and by Mr. Gene Williams, General Superintendent of Dresser Minerals, Inc., Mineral Point, Missouri, former owner of the facility.

b. Adequacy. The field surveys and visual inspections documented herein are considered adequate to support the conclusions of this report. Seepage and stability analyses comparable to the requirements of "Recommended Guidelines for the Safety Inspection of Dams" are not available; the lack of these analyses is considered to be a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions, including earthquake loads, and should be made a matter of record.

c. Validity. Not applicable.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General. The inspection team consisted of a civil engineer and an engineering geologist from International Engineering Company, Inc. The owner, Tom Villmer, met with the inspection team at the site. The impoundment is a barite tailings pond that the owner is converting into a farm. Some of the barite gravel at the crest of the dam is being excavated and sold by the owner. Photographs taken during the inspection are included in this report. Photograph locations are shown on Plate 6.

b. Project Geology. Bedrock in the area and underlying the dam is composed of the gray dolomite of the Potosi formation. Isolated outcrops are found over much of the surrounding area; these outcrops have been exposed by mining activities. Soil cover ranges from about 2 to 5 feet in thickness; the overburden soil is residual red stony, silty clay derived from the dolomite. The downslope areas east of the dike contain ponded water and seepage in many locations because the mined out area has a high water table. Mining of the overburden has probably caused the pattern of subsurface drainage to change.

c. Dam. The plan of the dam is shown on Plate 3. Profiles and sections are shown on Plates 4 and 5. Little vegetation is growing on the slopes of the dam. Some trees were buried during the dam enlargement process, and these were exposed in places on the downstream slope of the dam.

No detrimental settlement, depressions, sinkholes, animal burrows or evidence of past embankment overtopping was observed. The owner is presently excavating gravel from the crest of the dam at the southwest corner of the impoundment near the left abutment. Gravel has also been removed from these downstream embankment slopes near Stations 6+00 and 30+00 (Photo No. 7). The slope is excessively steep in these areas as a result of this mining activity. These slopes are probably at the angle of repose for the -7/8-inch barite gravels.

Evidence of ponded seepage was observed at the corner of the dam near Stations 29+00 to 31+00, (Photo No. 2). Several springs are located in this vicinity; seepage issuing from these springs totaled about 20 gpm and was clear.

Several minor seeps along the downstream toe between Stations 26+00 and 22+00 and a spring at Station 20+92 were also observed. The seeps were flowing at less than 1/2-gpm, and the spring was flowing clear at an estimated rate of 10 gpm. Bedrock outcrops and water pools were visible in the area around the seeps. Ground around the seeps was wet and saturated. The ground-water table appears to be very close to the surface and may cause the seepage.

Freeboard, the difference in height between the effective crest elevation and the adjacent tailings elevation, varies between 0 feet at Station 21+60 to greater than 3 feet. The effective crest of the dam was measured on the crest roadway. The owner's gravel mining activities on the dam crest have the effect of reducing freeboard.

The location of a low point on the dam crest is complicated by the gravel mining activities on the dam crest. An elevation of 724.7 was surveyed near Station 21+60 in an excavated area (Plate 7). Crest elevations in other areas where gravel was mined were measured in a similar fashion. However, the effective crest elevation for overtopping analyses was determined after evaluating field observations and the survey.

There is no protection against erosion on the slopes of the dam. There is only one abutment because the impoundment is almost completely enclosed by the dam; both ends of the dam tie into a knoll that consists of residual soil. This area was developed as a site for milling operations.

d. Appurtenant Structures. No spillway, diversion ditch, or defined downstream drainage channel exists at the damsite. Two pipes projecting through the embankment into the tailings pond at Stations 28+64 and 28+95 were observed. They are 8-inch and 6-inch steel pipes respectively. The invert elevations of the 8-inch pipe (Photo No. 4) and 6-inch pipe (Photo No. 5) are higher than the effective crest elevation at the low spot of the dam, so these outlets are not considered to have any effect in passing water from the pond; however, clear flow at 3 gpm was observed in the 6-inch pipe. This is probably due to leakage through pipe joints from water present in the tailings. The 8-inch pipe is exposed on the downstream face of the dam and both pipes terminate in or close to the embankment toe. Several pipes were located near Station 0+00; these are abandoned tailings discharge pipes. No evidence was found to indicate that these pipes have functioned recently.

e. Reservoir Area. No landslide activity or excessive erosion was observed in the reservoir area. Little sedimentation occurs at this site because of the small drainage basin, and there are no upstream hazards that might be subject to backwater flooding.

The impoundment consists of red silty clays that were deposited by hydraulic methods during active mine operations. No deposition has occurred for approximately 10 years. Some consolidation of the tailings has probably occurred, primarily in the immediate area adjacent to the dam where the tailings can drain. Also, the surface zones have desiccated, and small trees and grasses transpire some water from near the surface of the tailings.

Approximately 95 percent of the watershed area is covered by small trees and grass growing on barite ore tailings. The remaining area is sparsely vegetated to barren.

f. Downstream Channels. The downstream channel area is not defined and is relatively broad. The flow paths are lined with heavy brush, although the natural vegetation has been disturbed by mining activities in the area. The downstream area is not normally flood prone.

3.2 EVALUATION

The present owner's gravel mining activities are reducing the effective freeboard at the dam.

No functional spillway was observed. The two outlet pipes located appear to be incapable of passing impounded water. The lack of a spillway increases the likelihood of overtopping. The downstream slopes near Stations 30+00 and 6+00 are excessively steep due to past mining of gravel from the embankment toe.

Seepage and interrupted drainage was observed at the dam toe in several areas. No adequate means of draining this water was evident. This could weaken the foundation clay soil by saturation and adversely affect the stability of the dam.

The embankment is a relatively porous granular structure above the tailings surface. If the water level were to rise above the tailings surface due to flood runoff, there could be significant seepage through the embankment which could adversely affect the stability of the dam.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

No regulating procedures exist for the structure. No means of passing runoff water have been provided for this dam.

4.2 MAINTENANCE OF DAM

Information available to the inspection team indicates that the dam is not maintained. The owner is excavating gravel from the embankment crest.

4.3 MAINTENANCE OF OPERATING FACILITIES

Not applicable.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

To our knowledge there is no warning system in effect at this dam.

4.5 EVALUATION

A periodic inspection program should be initiated so that indications of instability, such as cracks in the dam, sloughing, sudden settlement, erosion of the dam, or an increase in the volume or turbidity of water from the springs or seeps, can be monitored. Maintenance of the dam is inadequate, and the practice of excavating gravels from the embankment should cease immediately.

SECTION 5 - HYDRAULIC AND HYDROLOGIC ANALYSES

5.1 EVALUATION OF FEATURES

a. Design Data. The significant dimensions of the dam are presented in Section 1 - Project Information, and also presented in the accompanying field survey drawings, Plates 3 through 6. Hydrologic or hydraulic design information are not available.

For this evaluation, the watershed drainage area and reservoir area-elevation data were measured using 1971 US Agricultural Stabilization and Conservation Service airphoto enlargements and survey data.

The total drainage area (including the reservoir) at Racola Tailings Dam, I.D. No. 30475, is almost enclosed by the embankment and is approximately 32 acres (0.05 square miles). The watershed location and drainage boundary are shown on Plate 2. Field surveys of the tailings behind the embankment (see Plate 4) showed the tailings profile was irregular and at different elevations. In order to obtain the active storage capacity, the spot surveys of the tailings elevations were transferred to the aerial photograph and used as a guide to develop contours of the tailings.

Almost the entire drainage area is covered by tailings deposits as a result of barite mining. For computations of "basin" characteristics, a lag time of 0.1 hour and antecedent moisture conditions (AMC) reflected by a runoff curve number (CN) of 100 were assumed for the computations of flood runoff for the tailings within the reservoir.

The input data and computed parameters, such as basin lag time, unit hydrograph, probable maximum precipitation, and the reservoir elevation-area-capacity data are in Appendix A. As shown in the computer print-outs, the reservoir surface areas are actual surface areas corresponding to the elevations shown. The capacities shown, as computed in the computer program by the Conic Method, are the active capacities at the given elevation. No spillway was present at the damsite. The abandoned pipes running through the embankment were assumed to be non-functional. Computations of the discharge rating curve for flows over the dam crest were made by using the weir flow formula with weir coefficients of $C=2.7$ for the excavated areas on the dam crest and 3.0 for the dam crest. The discharge rating curve for flows over the dam crest is in Appendix A, under the input data listing on the Y4 and Y5 cards. The overtopping analysis was based on the effective crest elevations as surveyed in the excavated areas on the dam crest. The excavated areas on the dam crest are assumed to be triangular and trapezoidal in shape at approximately Station 20+00 and Station 30+00 respectively for discharge computations and the effective crest elevation for overtopping was assumed to be at El. 726.0.

b. Experience Data. Rainfall, streamflow and flood data for the entire watershed are not available.

c. Visual Observations. Visual observations are discussed in Section 3 - Visual Observations.

During the field inspection, active gravel mining activities on the crest were observed (see Plate 4). This has effectively reduced the crest elevation, and with it the reservoir's ability to effectively retain runoff.

d. Overtopping Potential. The 100 year flood, probable maximum flood (PMF) and floods expressed as a percentage of PMF were computed and routed into and through the reservoir. The probable maximum flood is defined as the hypothetical flood event that would result from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible at a particular location or region.

The computed floods were routed through the project reservoir using the Modified Puls Method of flood routing. For all cases of the reservoir flood routing, the starting water surface elevation was set at El. 722.0, the observed water surface elevation during inspection.

Results of the overtopping analyses indicate that the dam is able to retain the 100-year flood. The studies indicate that the dam cannot retain the 50% PMF. It can handle about 32% of the PMF without overtopping the effective dam crest.

The primary effect of overtopping would be a greatly increased flow of water into the pervious embankment gravel. This flow would probably cause considerable erosion and movement of embankment gravels at the toe of the dam where the water would exit. A general movement of water over the crest and down the slope is also possible; however, most of this water would percolate into the embankment and exit at the toe. This mode would also probably cause erosion and movement of gravel at the toe.

Results of the overtopping analyses are reported in Appendix A and summarized below.

<u>Flood</u>	<u>Peak Inflow (cfs)</u>	<u>Peak Outflow (cfs)</u>	<u>Max WS Elev (ft)</u>	<u>Max Depth Over Min. Dam Crest (ft)</u>	<u>Duration Overtopped (hrs)</u>
10% PMF	72	0	724.1	0	-
25% PMF	180	0	725.5	0	-
32% PMF	230	0	726.0	0	-
50% PMF	360	136	726.2*	0.2	8.3
65% PMF	468	332	726.4*	0.4	8.7
80% PMF	576	419	726.5*	0.5	9.4
PMF	720	553	726.6*	0.6	10.2

* Dam overtopped (Minimum Dam Crest El. 726.0).

Note: Water surface elevations include the velocity heads corresponding to the velocities computed for the various flow depths for the overtopping section.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations. Visual observations of conditions that may adversely affect the structural stability of this dam are discussed in Section 3.

b. Design and Construction Data. No design or construction data pertaining to the structural stability of the dam were available. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, and lack of this information is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions, including earthquake loads, and made a matter of record.

c. Operating Records. No appurtenant structures are operable at this dam; no records of operations were located.

d. Post-Construction Changes. The dam has been enlarged during active mine operations, but no records are available concerning dates of enlargements, design, or materials used. Gravel has been excavated from the embankment crest and from the downstream slope after abandonment of barite tailings disposal operations.

e. Seismic Stability. The dam is located in Seismic Zone 2, to which the 1976 Uniform Building Code assigns a "moderate" damage potential. There appears to be a potential for instability caused by ground shaking during earthquakes where the dam overlies soft, saturated clay foundation soil. Some crest settlement and ravelling of the embankment gravels could also occur during seismic shaking because the gravels are in a relatively loose state and the downstream slope is at or near the natural angle of repose of the gravel.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety. Several deficient conditions at the dam should be corrected to improve the margin of safety. The absence of an operable spillway to remove storm runoff is the most serious deficiency. Other deficiencies noted are: soft foundation materials resulting from ponded seepage and springs at the dam toe; loss of freeboard resulting from the owner's gravel mining activities; excessively steep slopes resulting from mining of embankment gravels at the toe; and improperly installed pipes through the embankment. The soft foundation conditions caused by seepage and the excessively steep slopes caused by mining could adversely affect the stability of the dam. Suggested remedial measures are discussed in Section 7.2, REMEDIAL MEASURES.

b. Adequacy of information. No design or construction data were available. Seepage and stability analyses meeting the requirements of "Recommended Guidelines for the Safety Inspection of Dams" were not available, which is considered a deficiency.

Topographic data for this dam is not available. This is due primarily to the fact that the dam is divided by the border between two USGS quadrangle maps (a 7.5-minute and a 15-minute quadrangle map) and the mining activity occurred subsequent to the publication of the maps. The drainage area was measured after the dam was located on the original topography. Reservoir area capacity data and slopes were developed using survey measurements and constructing topographic contours on a 1 inch = 660 feet air photo enlargement showing the reservoir and watershed areas. This data is considered adequate for a Phase I analysis; however, the evaluation of overtopping potential is approximate due to the available data.

c. Urgency. The lack of a spillway and lowering of effective freeboard by mining gravel from the crest, are serious deficiencies. Measures to correct these deficiencies should be initiated without delay.

d. Necessity for Phase II. Additional studies are not recommended for this dam, with the exception of seepage and stability analyses and a reclamation plan as described below in Section 7.2.

7.2 REMEDIAL MEASURES

a. Spillway. An adequate spillway should be designed to safely pass the PMF without causing erosion of the embankment under the Guidelines established by the Corps of Engineers. An engineer experienced in the design of dam spillways should be retained for the design and supervision of construction of the spillway.

b. Increase in Freeboard. The practice of excavating gravel from the embankment crest, particularly near Stations 30+00+ and 21+00+ should cease immediately. These excavated areas should be refilled with similar materials to increase freeboard at the low spots of the dam.

c. Drainage of Seepage. Seepage that presently ponds at the dam in various locations between Stations 20+00 and 34+00 should be drained to remove water which saturates and weakens foundation soil.

d. Modification of Slopes. The overly steep downstream slope near Stations 6+00 and 30+00 should be regraded to flatten the slope where past gravel mining at the toe has occurred.

e. Grouting of Buried Pipes. The two non-functioning outlet pipes near Station 29+00 should be plugged with grout. This will prevent the possibility of internal erosion of tailings and embankment materials when the pipes corrode around the joints and permit seepage and fines to enter the conduits.

f. Inspection Program. The dam should be inspected periodically by an engineer who will observe and record the performance of the dam. The springs and seeps should be monitored as part of the inspection program. Records of these inspections should be maintained, and all maintenance or remedial measures performed at the site should be documented.

g. Stability and Seepage Analyses should be performed by an engineer experienced in the design and construction of tailings dams. The embankment is a relatively porous granular structure above the tailings surface. If the impoundment water level were to rise above the tailings surface, there could be significant seepage through the embankment which could adversely affect the stability of the dam. Included in these analyses, therefore, seepage and stability computations should also be performed with the reservoir water surface set at the top of the dam. Based on the results of these studies, remedial measures may be necessary. Remedial work should be done under the direction of an engineer experienced in tailings dam design and construction.

h. Deactivation of Impoundment. As an alternative to the above remedial measures, a plan to permanently drain the impoundment and reclaim the embankment and tailings pond could be developed. Such a plan should make provisions for the safe removal of storm runoff and maintain the stability of the dam and impounded tailings at all times. Preparation of a reclamation plan and reclamation activities should be accomplished under the direction of an engineer experienced in the design and construction of tailings dams.

APPENDIX A

HYDROLOGIC AND HYDRAULIC ANALYSES

The hydrologic and hydraulic analyses were accomplished by using the computer program "Flood Hydrograph Package, HEC-1, Dam Safety Investigations Version, July 1978". This program was developed by the Hydrologic Engineering Center, U.S. Army Corps of Engineers, Davis, California. The criteria and methodology used are briefly discussed below:

- Probable Maximum Precipitation (PMP) - The 24-hour PMP was obtained from Hydrometeorological Report No. 33. The 6-hour and the 1-hour depth-duration distributions followed Corps of Engineers EM 1110-2-1411 criteria.
- 100-year and/or 10-year storms - The 24-hour storm amounts and distributions were supplied by Corps of Engineers, St. Louis District, Missouri.
- Reservoir Area-Capacity - Areas were measured from U.S.G.S. topographic maps and/or from aerial photographs. Reservoir elevations and corresponding surface areas were input into the computer program, which determined the reservoir capacities by the Conic Method.
- Flood Routing - The Modified Puls Method was used for all flood routing and dam overtopping analyses.

The following pages present the input data listing, the computer program version and its last modification date, together with pertinent computer printouts of results. Definitions of all input and output variable names are presented in the September 1978 computer program "Users Manual", and are not explained herein.

 FLOOD HYDROGRAPH PACKAGE (HEC-1)
 DAM SAFETY VERSION JULY 1978
 LAST MODIFICATION 26 FEB 79

RUN DATE= 79/07/24.
 TIME= 14.42.43.

RACOLA DAM ID NO 30875
 HEC-1 PHASE 1 DAM SAFETY INVESTIGATION
 PHF ROUTING THROUGH CLOSED SYSTEM

JOB SPECIFICATION									
NO	MHR	MMIN	IDAY	IMH	IMIN	METRC	IPLY	IPRT	INSTAN
288	0	5	0	0	0	0	0	0	0
			JOPER	NWT	LRUP	TRACE			
			5	0	0	0			

MULTI-PLAN ANALYSES TO BE PERFORMED
 NPLAN= 1 NRTIO= 7 LRTIO= 1
 RTIOS= .10 .25 .32 .50 .65 .80 1.00

***** SUB-AREA RUNOFF COMPUTATION *****

PHF INFLOW TO CLOSED SYSTEM OF WATERSHED AND POND ID NO 30875

INSTAD	ICOMP	IECON	ITAPE	JPLY	JPRI	INAME	ISTAGE	IAUTO
0	0	0	0	0	1	1	0	0
INFLW								

HYDROGRAPH DATA									
IMYDC	IUNG	TAKEA	SNAP	THSDA	TRSPC	RATIO	ISMOW	ISAME	LOCAL
1	2	.05	0.00	.05	1.00	0.000	0	1	0

PRECIP DATA									
SPEE	PKS	R6	R12	R24	R48	RT2	R96		
0.00	25.70	102.00	120.00	130.00	0.00	0.00	0.00		

LOSS DATA									
LHOP	SIRKR	DLTKR	RTIOL	ERAIN	STWKS	RTIOW	STRIL	CNSTL	ALSMX
0	0.00	0.00	1.00	0.00	0.00	1.00	00	-100.00	0.00

CURVE NO = -100.00 METNESS = -1.00 EFFECT CN = 100.00

UNIT HYDROGRAPH DATA
 TC= 0.00 LAG= .10

RECESSION DATA
 STRIO= -.01 ONCSN= -.01 RTIOR= 1.00

TIME INCREMENT TOO LARGE--(NHW IS GT LAU/2)

UNIT HYDROGRAPH B END OF PERIOD ORDIN :S, TC= 0.00 HOURS, LAG= .10 VOL= 1.00

109.	162.	71.	28.	11.	8.	2.	1.						
MO. DA	HR. MN	PERIOD	RAIN	EXCS	LOSS	END-OF-PERIOD FLOW COMP. J	MO. DA	HR. MN	PERIOD	RAIN	EXCS	LOSS	COMP. Q
1.01	1.05	1	.01	.01	0.00	2.	1.01	12.05	145	.22	.22	.00	42.
1.01	1.10	2	.01	.01	0.00	4.	1.01	12.10	146	.22	.22	.00	67.
1.01	1.15	3	.01	.01	0.00	5.	1.01	12.15	147	.22	.22	.00	78.
1.01	1.20	4	.01	.01	0.00	5.	1.01	12.20	148	.22	.22	.00	62.
1.01	1.25	5	.01	.01	0.00	5.	1.01	12.25	149	.22	.22	.00	84.
1.01	1.30	6	.01	.01	0.00	5.	1.01	12.30	150	.22	.22	.00	64.
1.01	1.35	7	.01	.01	0.00	6.	1.01	12.35	151	.22	.22	.00	64.
1.01	1.40	8	.01	.01	0.00	6.	1.01	12.40	152	.22	.22	.00	65.
1.01	1.45	9	.01	.01	0.00	6.	1.01	12.45	153	.22	.22	.00	65.
1.01	1.50	10	.01	.01	0.00	6.	1.01	12.50	154	.22	.22	.00	65.
1.01	1.55	11	.01	.01	0.00	6.	1.01	12.55	155	.22	.22	.00	65.
1.01	1.00	12	.01	.01	0.00	6.	1.01	13.00	156	.22	.22	.00	65.
1.01	1.05	13	.01	.01	0.00	6.	1.01	13.05	157	.26	.26	.00	69.
1.01	1.10	14	.01	.01	0.00	6.	1.01	13.10	158	.26	.26	.00	66.
1.01	1.15	15	.01	.01	0.00	6.	1.01	13.15	159	.26	.26	.00	100.
1.01	1.20	16	.01	.01	0.00	6.	1.01	13.20	160	.26	.26	.00	101.
1.01	1.25	17	.01	.01	0.00	6.	1.01	13.25	161	.26	.26	.00	101.
1.01	1.30	18	.01	.01	0.00	6.	1.01	13.30	162	.26	.26	.00	101.
1.01	1.35	19	.01	.01	0.00	6.	1.01	13.35	163	.26	.26	.00	101.
1.01	1.40	20	.01	.01	0.00	6.	1.01	13.40	164	.26	.26	.00	101.
1.01	1.45	21	.01	.01	0.00	6.	1.01	13.45	165	.26	.26	.00	101.
1.01	1.50	22	.01	.01	0.00	6.	1.01	13.50	166	.26	.26	.00	101.
1.01	1.55	23	.01	.01	0.00	6.	1.01	13.55	167	.26	.26	.00	101.
1.01	2.00	24	.01	.01	0.00	6.	1.01	14.00	168	.26	.26	.00	101.
1.01	2.05	25	.01	.01	0.00	6.	1.01	14.05	169	.33	.33	.00	109.
1.01	2.10	26	.01	.01	0.00	6.	1.01	14.10	170	.33	.33	.00	119.
1.01	2.15	27	.01	.01	0.00	6.	1.01	14.15	171	.33	.33	.00	124.
1.01	2.20	28	.01	.01	0.00	6.	1.01	14.20	172	.33	.33	.00	126.
1.01	2.25	29	.01	.01	0.00	6.	1.01	14.25	173	.33	.33	.00	126.
1.01	2.30	30	.01	.01	0.00	6.	1.01	14.30	174	.33	.33	.00	127.
1.01	2.35	31	.01	.01	0.00	6.	1.01	14.35	175	.33	.33	.00	127.
1.01	2.40	32	.01	.01	0.00	6.	1.01	14.40	176	.33	.33	.00	127.
1.01	2.45	33	.01	.01	0.00	6.	1.01	14.45	177	.33	.33	.00	127.
1.01	2.50	34	.01	.01	0.00	6.	1.01	14.50	178	.33	.33	.00	127.
1.01	2.55	35	.01	.01	0.00	6.	1.01	14.55	179	.33	.33	.00	127.
1.01	3.00	36	.01	.01	0.00	6.	1.01	15.00	180	.33	.33	.00	127.
1.01	3.05	37	.01	.01	0.00	6.	1.01	15.05	181	.20	.20	.00	113.
1.01	3.10	38	.01	.01	0.00	6.	1.01	15.10	182	.40	.40	.00	114.
1.01	3.15	39	.01	.01	0.00	6.	1.01	15.15	183	.40	.40	.00	137.
1.01	3.20	40	.01	.01	0.00	6.	1.01	15.20	184	.60	.60	.00	149.
1.01	3.25	41	.01	.01	0.00	6.	1.01	15.25	185	.70	.70	.00	217.
1.01	3.30	42	.01	.01	0.00	6.	1.01	15.30	186	1.69	1.69	.00	354.
1.01	3.35	43	.01	.01	0.00	6.	1.01	15.35	187	2.79	2.79	.00	652.
1.01	3.40	44	.01	.01	0.00	6.	1.01	15.40	188	1.10	1.10	.00	720.
1.01	3.45	45	.01	.01	0.00	6.	1.01	15.45	189	.70	.70	.00	510.
1.01	3.50	46	.01	.01	0.00	6.	1.01	15.50	190	.60	.60	.00	355.
1.01	3.55	47	.01	.01	0.00	6.	1.01	15.55	191	.40	.40	.00	258.
1.01	4.00	48	.01	.01	0.00	6.	1.01	16.00	192	.40	.40	.00	196.
1.01	4.05	49	.01	.01	0.00	6.	1.01	16.05	193	.31	.31	.00	160.
1.01	4.10	50	.01	.01	0.00	6.	1.01	16.10	194	.31	.31	.00	135.
1.01	4.15	51	.01	.01	0.00	6.	1.01	16.15	195	.31	.31	.00	124.
1.01	4.20	52	.01	.01	0.00	6.	1.01	16.20	196	.31	.31	.00	120.
1.01	4.25	53	.01	.01	0.00	6.	1.01	16.25	197	.31	.31	.00	119.
1.01	4.30	54	.01	.01	0.00	6.	1.01	16.30	198	.31	.31	.00	119.
1.01	4.35	55	.01	.01	0.00	6.	1.01	16.35	199	.31	.31	.00	116.

1.01	4.40	56	.01	.01	6.	1.01	16.40	200	.31	-.00	110.
1.01	4.45	57	.01	.01	6.	1.01	16.45	201	.31	-.00	110.
1.01	4.50	58	.01	.01	6.	1.01	16.50	202	.31	-.00	110.
1.01	4.55	59	.01	.01	6.	1.01	16.55	203	.31	-.00	110.
1.01	5.00	60	.01	.01	6.	1.01	17.00	204	.31	-.00	110.
1.01	5.05	61	.01	.01	6.	1.01	17.05	205	.24	-.00	111.
1.01	5.10	62	.01	.01	6.	1.01	17.10	206	.24	-.00	101.
1.01	5.15	63	.01	.01	6.	1.01	17.15	207	.24	-.00	96.
1.01	5.20	64	.01	.01	6.	1.01	17.20	208	.24	-.00	94.
1.01	5.25	65	.01	.01	6.	1.01	17.25	209	.24	-.00	93.
1.01	5.30	66	.01	.01	6.	1.01	17.30	210	.24	-.00	93.
1.01	5.35	67	.01	.01	6.	1.01	17.35	211	.24	-.00	93.
1.01	5.40	68	.01	.01	6.	1.01	17.40	212	.24	-.00	93.
1.01	5.45	69	.01	.01	6.	1.01	17.45	213	.24	-.00	93.
1.01	5.50	70	.01	.01	6.	1.01	17.50	214	.24	-.00	93.
1.01	5.55	71	.01	.01	6.	1.01	17.55	215	.24	-.00	93.
1.01	6.00	72	.01	.01	6.	1.01	18.00	216	.24	-.00	93.
1.01	6.05	73	.06	.06	11.	1.01	18.05	217	.02	-.00	69.
1.01	6.10	74	.06	.06	19.	1.01	18.10	218	.02	-.00	34.
1.01	6.15	75	.06	.06	23.	1.01	18.15	219	.02	-.00	18.
1.01	6.20	76	.06	.06	24.	1.01	18.20	220	.02	-.00	12.
1.01	6.25	77	.06	.06	25.	1.01	18.25	221	.02	-.00	10.
1.01	6.30	78	.06	.06	25.	1.01	18.30	222	.02	-.00	9.
1.01	6.35	79	.06	.06	25.	1.01	18.35	223	.02	-.00	8.
1.01	6.40	80	.06	.06	25.	1.01	18.40	224	.02	-.00	8.
1.01	6.45	81	.06	.06	25.	1.01	18.45	225	.02	-.00	8.
1.01	6.50	82	.06	.06	25.	1.01	18.50	226	.02	-.00	8.
1.01	6.55	83	.06	.06	25.	1.01	18.55	227	.02	-.00	8.
1.01	7.00	84	.06	.06	25.	1.01	19.00	228	.02	-.00	8.
1.01	7.05	85	.06	.06	25.	1.01	19.05	229	.02	-.00	8.
1.01	7.10	86	.06	.06	25.	1.01	19.10	230	.02	-.00	8.
1.01	7.15	87	.06	.06	25.	1.01	19.15	231	.02	-.00	8.
1.01	7.20	88	.06	.06	25.	1.01	19.20	232	.02	-.00	8.
1.01	7.25	89	.06	.06	25.	1.01	19.25	233	.02	-.00	8.
1.01	7.30	90	.06	.06	25.	1.01	19.30	234	.02	-.00	8.
1.01	7.35	91	.06	.06	25.	1.01	19.35	235	.02	-.00	8.
1.01	7.40	92	.06	.06	25.	1.01	19.40	236	.02	-.00	8.
1.01	7.45	93	.06	.06	25.	1.01	19.45	237	.02	-.00	8.
1.01	7.50	94	.06	.06	25.	1.01	19.50	238	.02	-.00	8.
1.01	7.55	95	.06	.06	25.	1.01	19.55	239	.02	-.00	8.
1.01	8.00	96	.06	.06	25.	1.01	20.00	240	.02	-.00	8.
1.01	8.05	97	.06	.06	25.	1.01	20.05	241	.02	-.00	8.
1.01	8.10	98	.06	.06	25.	1.01	20.10	242	.02	-.00	8.
1.01	8.15	99	.06	.06	25.	1.01	20.15	243	.02	-.00	8.
1.01	8.20	100	.06	.06	25.	1.01	20.20	244	.02	-.00	8.
1.01	8.25	101	.06	.06	25.	1.01	20.25	245	.02	-.00	8.
1.01	8.30	102	.06	.06	25.	1.01	20.30	246	.02	-.00	8.
1.01	8.35	103	.06	.06	25.	1.01	20.35	247	.02	-.00	8.
1.01	8.40	104	.06	.06	25.	1.01	20.40	248	.02	-.00	8.
1.01	8.45	105	.06	.06	25.	1.01	20.45	249	.02	-.00	8.
1.01	8.50	106	.06	.06	25.	1.01	20.50	250	.02	-.00	8.
1.01	8.55	107	.06	.06	25.	1.01	20.55	251	.02	-.00	8.
1.01	9.00	108	.06	.06	25.	1.01	21.00	252	.02	-.00	8.
1.01	9.05	109	.06	.06	25.	1.01	21.05	253	.02	-.00	8.
1.01	9.10	110	.06	.06	25.	1.01	21.10	254	.02	-.00	8.
1.01	9.15	111	.06	.06	25.	1.01	21.15	255	.02	-.00	8.
1.01	9.20	112	.06	.06	25.	1.01	21.20	256	.02	-.00	8.
1.01	9.25	113	.06	.06	25.	1.01	21.25	257	.02	-.00	8.
1.01	9.30	114	.06	.06	25.	1.01	21.30	258	.02	-.00	8.
1.01	9.35	115	.06	.06	25.	1.01	21.35	259	.02	-.00	8.

1.01	9.40	116	.06	.06	.00	25.	1.01	21.40	260	.02	.02	.00	6.
1.01	9.45	117	.06	.06	.00	25.	1.01	21.45	261	.02	.02	.00	6.
1.01	9.50	118	.06	.06	.00	25.	1.01	21.50	262	.02	.02	.00	6.
1.01	9.55	119	.06	.06	.00	25.	1.01	21.55	263	.02	.02	.00	6.
1.01	10.00	120	.06	.06	.00	25.	1.01	22.00	264	.02	.02	.00	6.
1.01	10.05	121	.06	.06	.00	25.	1.01	22.05	265	.02	.02	.00	6.
1.01	10.10	122	.06	.06	.00	25.	1.01	22.10	266	.02	.02	.00	6.
1.01	10.15	123	.06	.06	.00	25.	1.01	22.15	267	.02	.02	.00	6.
1.01	10.20	124	.06	.06	.00	25.	1.01	22.20	268	.02	.02	.00	6.
1.01	10.25	125	.06	.06	.00	25.	1.01	22.25	269	.02	.02	.00	6.
1.01	10.30	126	.06	.06	.00	25.	1.01	22.30	270	.02	.02	.00	6.
1.01	10.35	127	.06	.06	.00	25.	1.01	22.35	271	.02	.02	.00	6.
1.01	10.40	128	.06	.06	.00	25.	1.01	22.40	272	.02	.02	.00	6.
1.01	10.45	129	.06	.06	.00	25.	1.01	22.45	273	.02	.02	.00	6.
1.01	10.50	130	.06	.06	.00	25.	1.01	22.50	274	.02	.02	.00	6.
1.01	10.55	131	.06	.06	.00	25.	1.01	22.55	275	.02	.02	.00	6.
1.01	11.00	132	.06	.06	.00	25.	1.01	23.00	276	.02	.02	.00	6.
1.01	11.05	133	.06	.06	.00	25.	1.01	23.05	277	.02	.02	.00	6.
1.01	11.10	134	.06	.06	.00	25.	1.01	23.10	278	.02	.02	.00	6.
1.01	11.15	135	.06	.06	.00	25.	1.01	23.15	279	.02	.02	.00	6.
1.01	11.20	136	.06	.06	.00	25.	1.01	23.20	280	.02	.02	.00	6.
1.01	11.25	137	.06	.06	.00	25.	1.01	23.25	281	.02	.02	.00	6.
1.01	11.30	138	.06	.06	.00	25.	1.01	23.30	282	.02	.02	.00	6.
1.01	11.35	139	.06	.06	.00	25.	1.01	23.35	283	.02	.02	.00	6.
1.01	11.40	140	.06	.06	.00	25.	1.01	23.40	284	.02	.02	.00	6.
1.01	11.45	141	.06	.06	.00	25.	1.01	23.45	285	.02	.02	.00	6.
1.01	11.50	142	.06	.06	.00	25.	1.01	23.50	286	.02	.02	.00	6.
1.01	11.55	143	.06	.06	.00	25.	1.01	23.55	287	.02	.02	.00	6.
1.01	12.00	144	.06	.06	.00	25.	1.02	0.00	288	.02	.02	.00	6.
SUM									33.41	33.41	.00	129.2.	
									(.846)	(.849.)	.0.1	366.48)	

PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
720.	180.	45.	45.	12415.
20.	4.	1.	1.	300.
	26.04	33.37	33.37	33.37
	661.34	847.65	847.65	847.65
	89.	89.	89.	89.
	86.	110.	110.	110.

HYDROGRAPH ROUTING

ROUTING THROUGH CLOSED SYSTEM

ISTAO	ICOMP	IECON	ITAPE	JPLT	JPRY	INAME	ISTAGE	IAUTO
CLSSYS	1	0	0	0	1	1	0	0
ROUTING DATA								
QLOSS	CLOSS	AVG	IRHS	ISAME	IOPT	IPMP	LSTR	
0.0	0.000	0.00	1	1	0	0	0	
NSTPS NSTDL LAG ANSKK X TSK STORA ISPRAT								
	1	0	0	0.000	0.000	0.000	-722.	-1

STAGE	720.00	726.00	726.56	727.67	728.23	728.78
-------	--------	--------	--------	--------	--------	--------

FLOW	0.00	-00	462.00	2602.00	4119.00	5936.00
------	------	-----	--------	---------	---------	---------

SURFACE AREA	0.	11.	12.	19.	21.	26.
--------------	----	-----	-----	-----	-----	-----

CAPACITY	0.	16.	29.	89.	99.	117.
----------	----	-----	-----	-----	-----	------

ELEVATIONS	720.	725.	726.	730.	731.	731.
------------	------	------	------	------	------	------

CHEL	SPWID	COWW	EXPM	ELEV	COUL	CAREA	EXPL
726.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

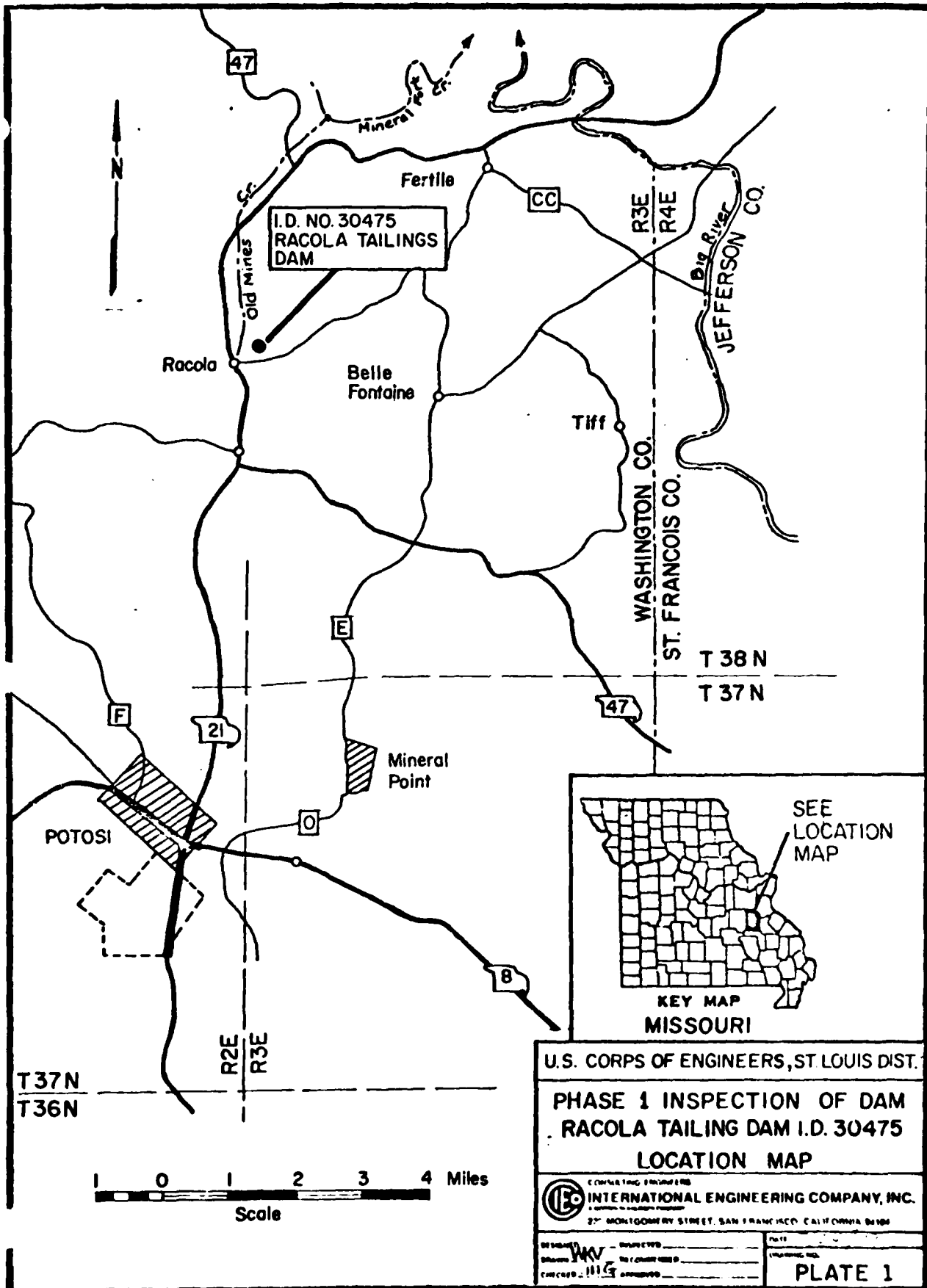
DAM DATA			
TOPEL	CO30	EXPD	DAMWID
726.0	0.0	0.0	0.

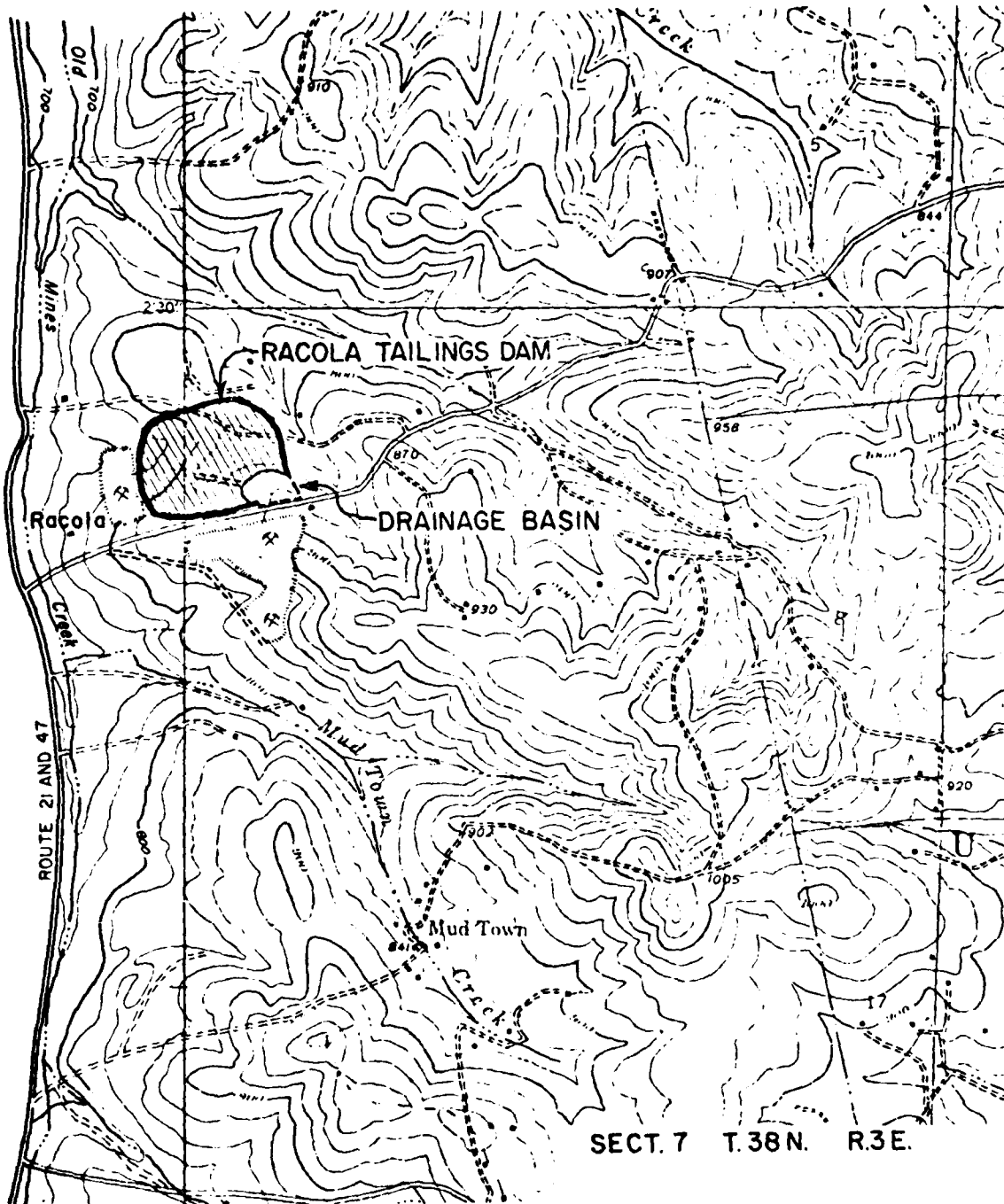
PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
 FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
 AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIO 1	RATIO 2	RATIOS APPLIED TO FLOWS						
						RATIO 3	RATIO 4	RATIO 5	RATIO 6	RATIO 7		
				.10	.25	.32	.50	.65	.80	1.00		
HYDROGRAPH AT INFLOW	(	.05	1	72.	180.	230.	360.	460.	576.	720.		
	(	.13)	(	2.04)	5.10)	6.53)	10.20)	13.26)	16.31)	20.34)	(
ROUTED TO	CLSSTS	.05	1	0.	0.	0.	136.	332.	414.	553.		
	(	.13)	(	.00)	.00)	.00)	3.80)	9.40)	11.85)	15.66)	(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1									
RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS	TOP OF DAM	
								INITIAL VALUE	SPILLWAY CREST
			722.00	726.00				726.00	
			1.	29.				29.	
			0.	0.				0.	
.10	724.07	0.00	10.	0.	0.00	24.00	0.00		
.25	725.48	0.00	23.	0.	0.00	24.00	0.00		
.32	725.99	0.00	29.	0.	0.00	24.00	0.00		
.50	726.16	.16	31.	136.	8.33	15.92	0.00		
.65	726.59	.39	33.	332.	8.67	15.75	0.00		
.80	726.49	.49	35.	414.	9.42	15.75	0.00		
1.00	726.60	.60	36.	553.	10.17	15.75	0.00		





Scale 1000 0 1000 2000 3000 4000 Feet

U.S. CORPS OF ENGINEERS, ST. LOUIS DIST.

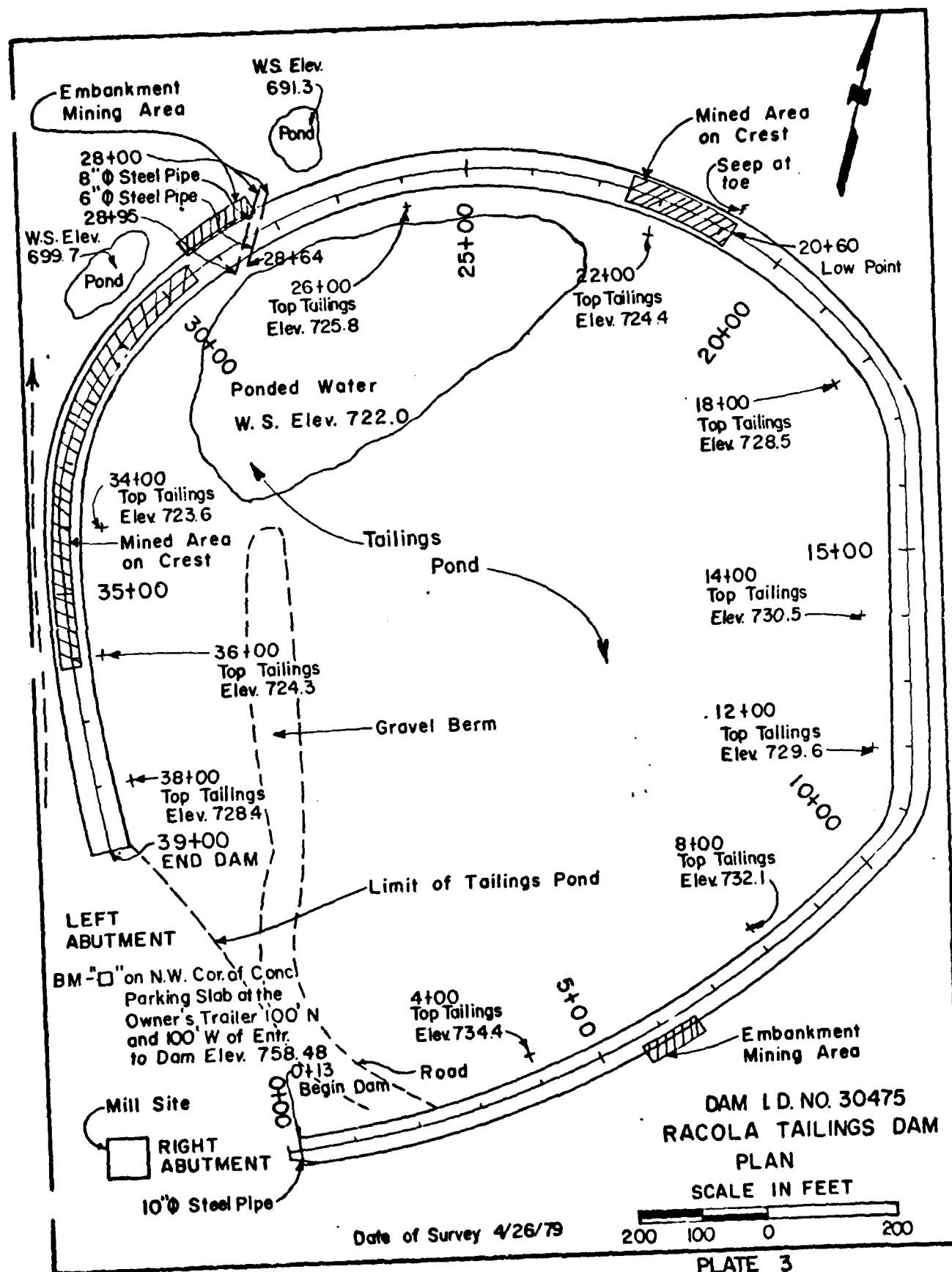
PHASE I INSPECTION OF DAMS
RACOLA TAILINGS DAM I.D. NO. 30475
VICINITY TOPOGRAPHY

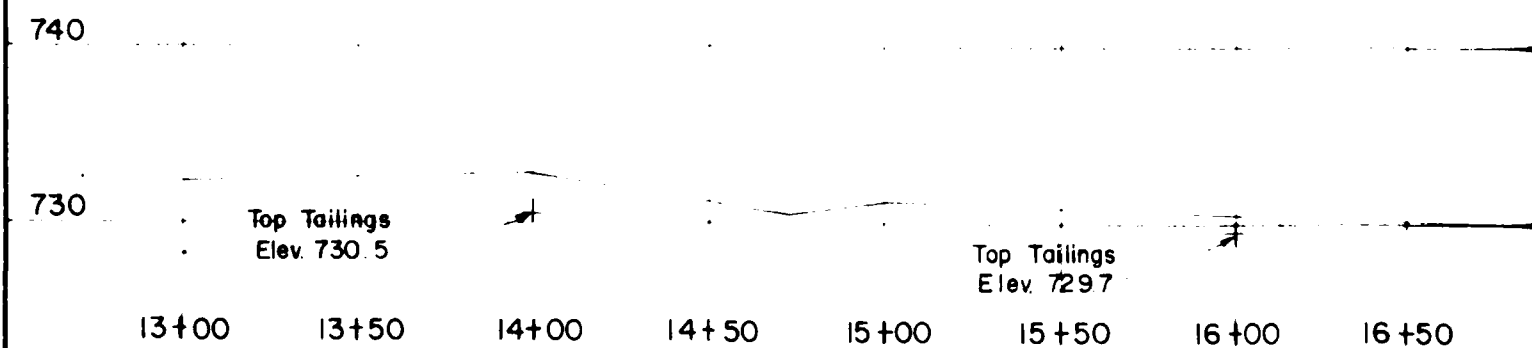
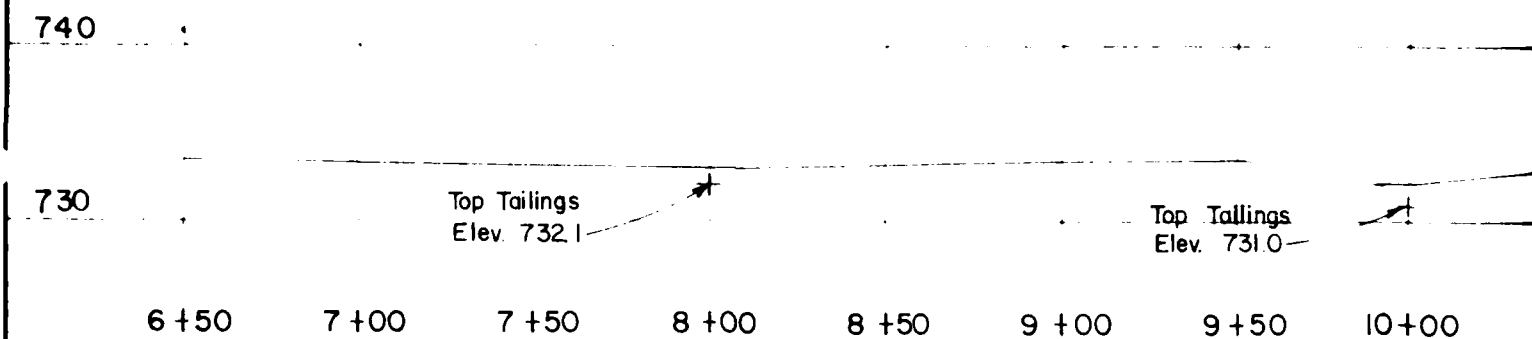
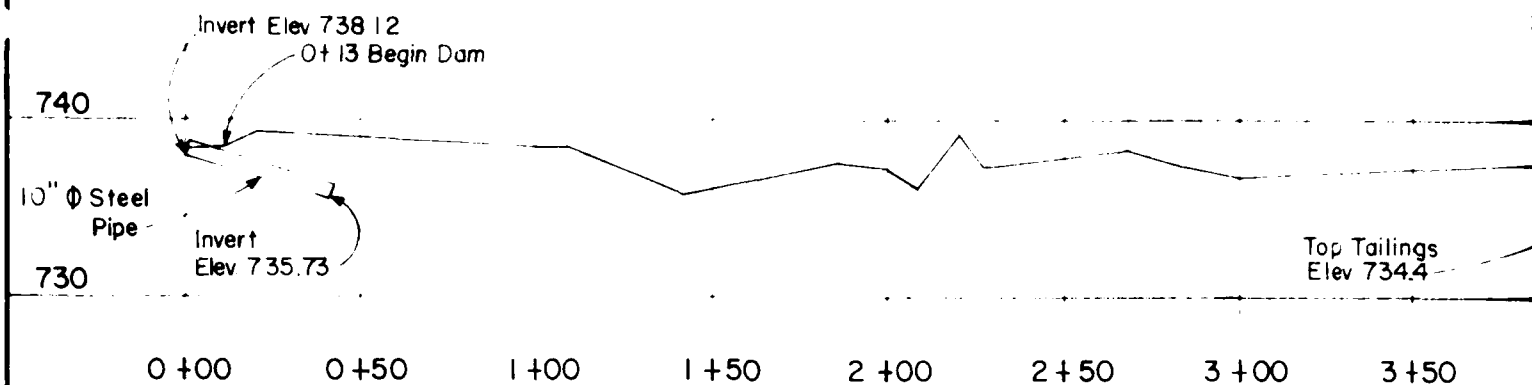
INTERNATIONAL ENGINEERING COMPANY, INC.
270 MONTGOMERY STREET, SAN FRANCISCO, CALIFORNIA 94104

DESIGNED BY _____ INSPECTED BY _____
DRAWN BY _____ RE-CHECKED BY _____
CHECKED BY _____ APPROVED BY _____

DATE
DRAWN BY

PLATE 2





Cross-Section at 6+00

Excavation of
Dam on
Right Side

Top Tailings
Elev. 734.4

Top Tailings
Elev. 733.7

+00 3+50 4+00 4+50 5+00 5+50 6+00 6+50

Top Tailings
Elev. 731.0

Top Tailings
Elev. 729.6

+50 10+00 10+50 11+00 11+50 12+00 12+50 13+00

Top Tailings
Elev. 728.5

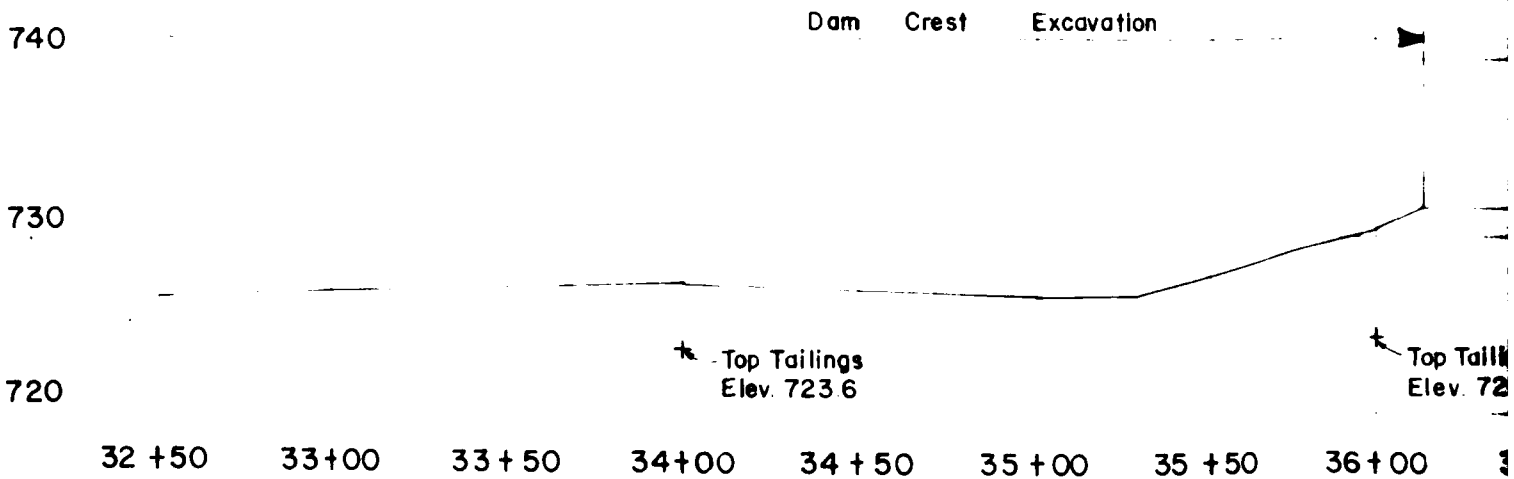
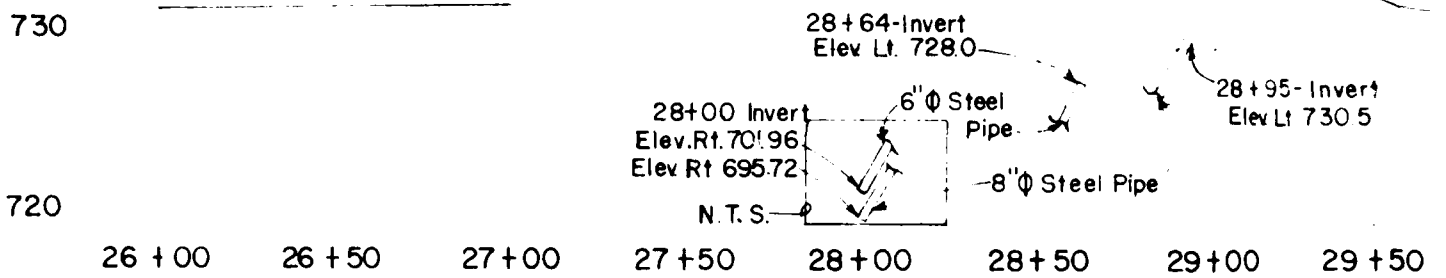
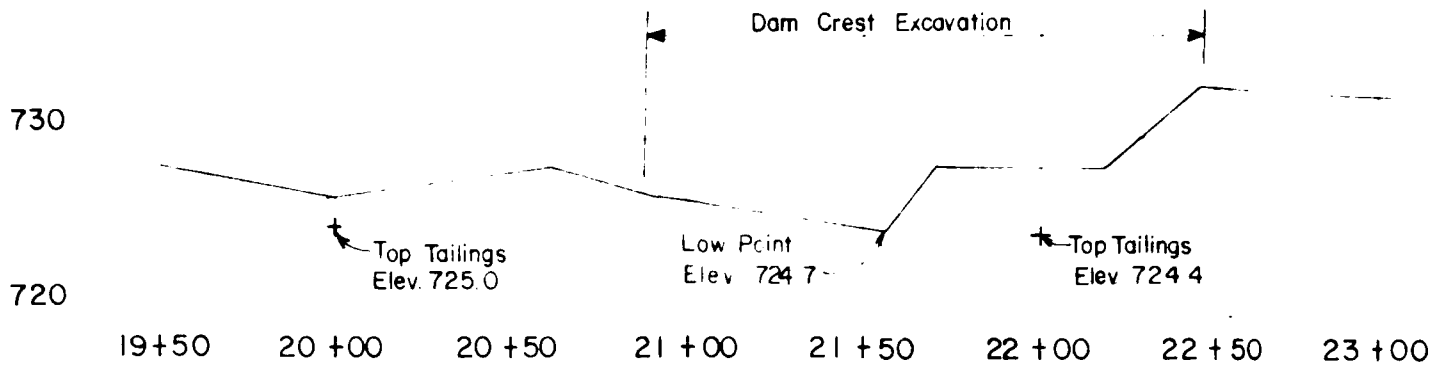
+00 16+50 17+00 17+50 18+00 18+50

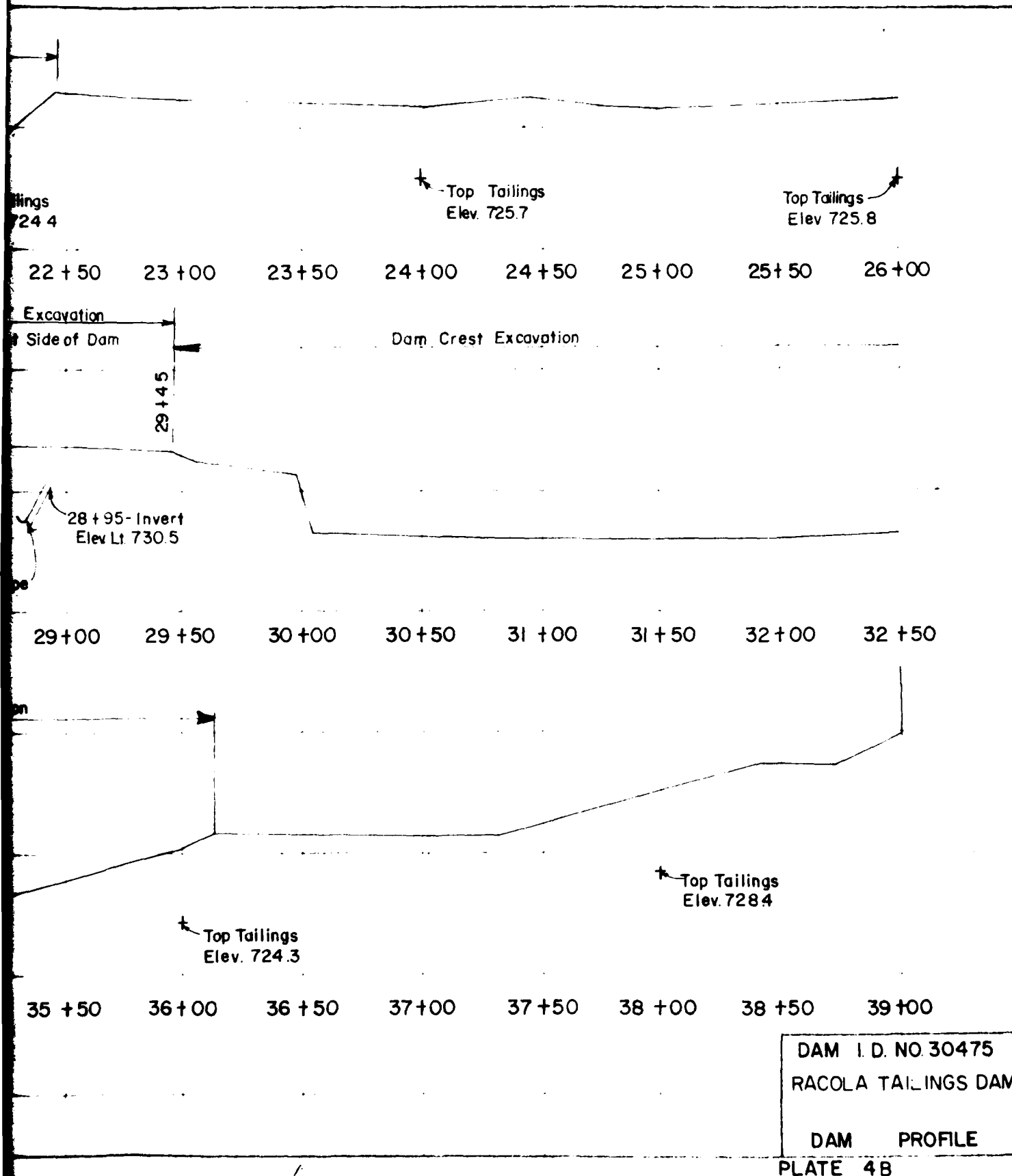
19+00 19+50

DAM I.D. NO. 30475
RACOLA TAILINGS DAM

DAM PROFILE

PLATE 4A





740

700

200

160

120

80

40

0

Top Tailings

Dam
Crest

DAM CROSS SECTION AT STA. 3

740

700

200

160

120

80

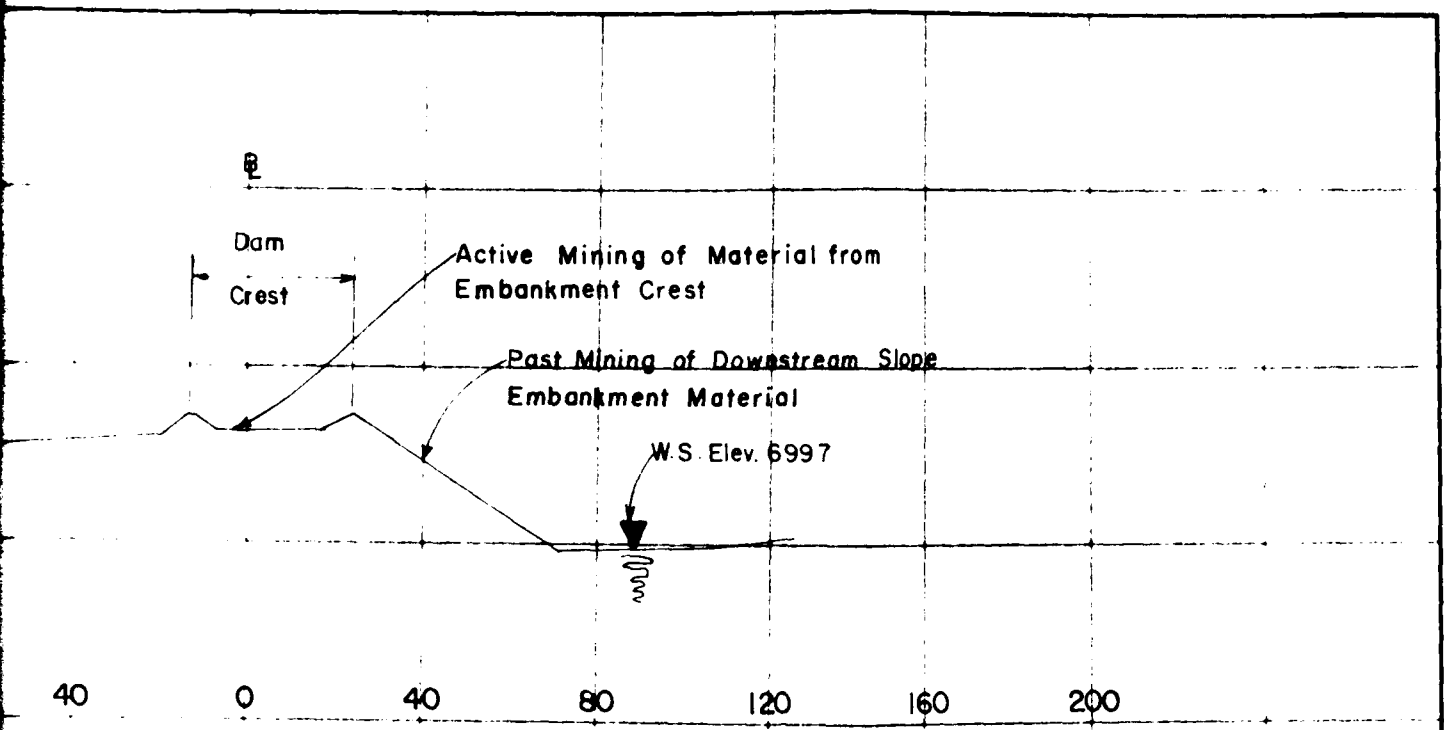
40

0

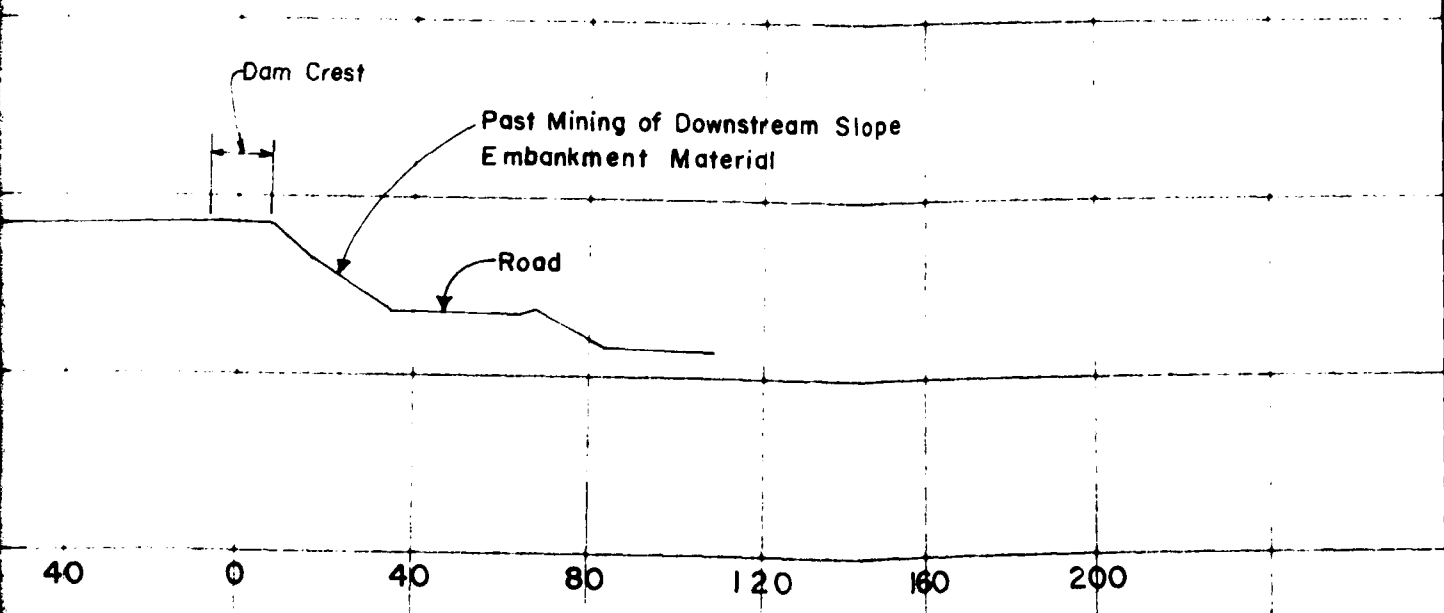
Top Tailings

Dam Crest

DAM CROSS-SECTION AT ST



CROSS SECTION AT STA. 30+72



CROSS-SECTION AT STA. 6+00

DAM I.D. NO. 30475
 RACOLA TAILINGS DAM
 DAM CROSS-SECTIONS

740

Top Tailings

Dam
Crest

700

660

620

240

200

160

120

80

40

0

DAM CROSS-SECTION AT STA.

Dam
Crest

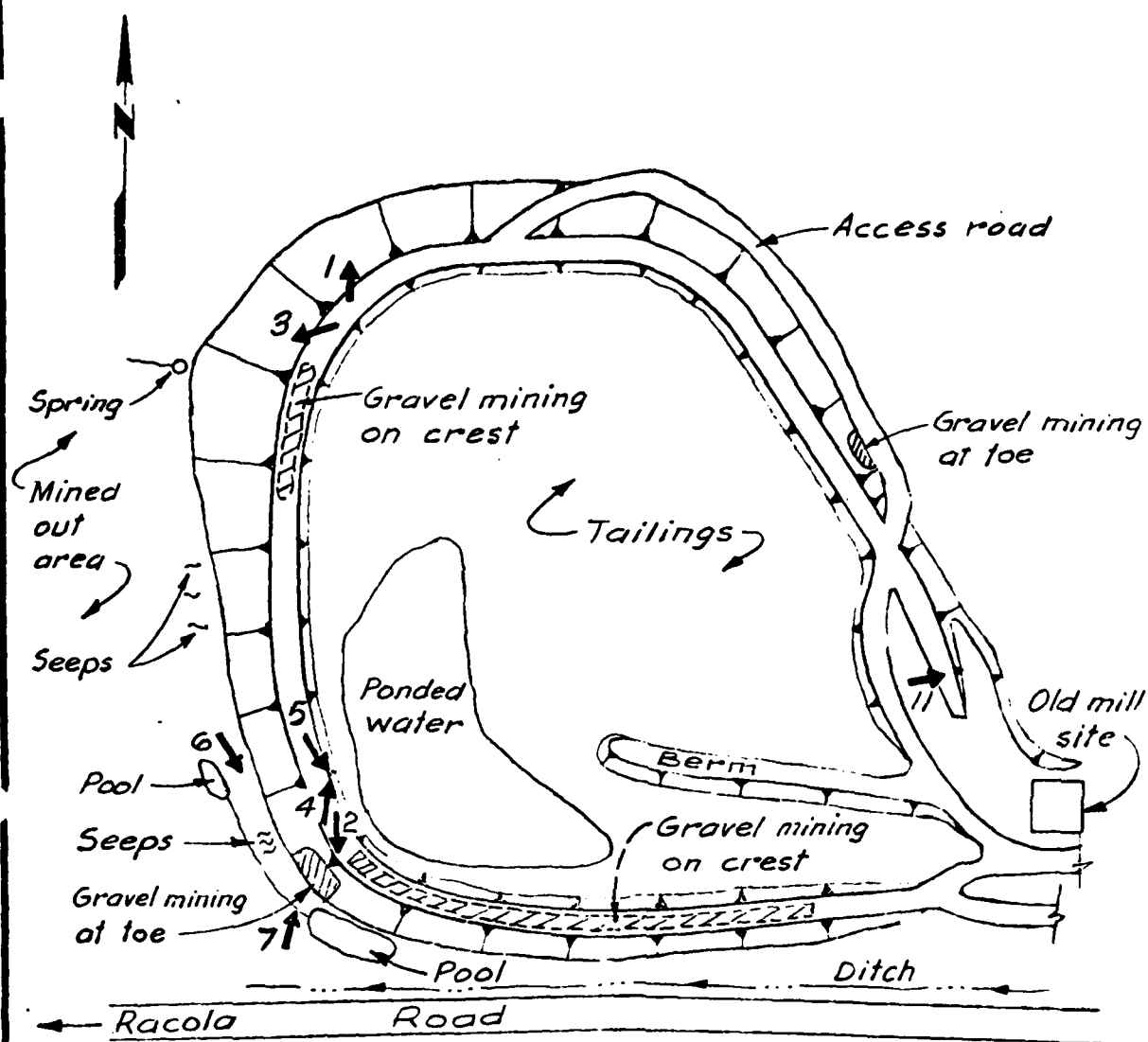
Seep - Elev 648.1 (flowing at 10 gpm
on 4/15/79)

40 0 40 80 120 160 200 240

CROSS-SECTION AT STA 20+89

DAM I.D. NO. 30475
RACOLA TAILINGS DAM
DAM CROSS-SECTION

PLATE 5B



LEGEND:

4 → Photo No. and view direction

U.S. CORPS OF ENGINEERS, ST. LOUIS DIST.

PHASE I INSPECTION OF DAMS
RACOLA TAILINGS DAM I.D. NO. 30475
PHOTOGRAPH LOCATIONS



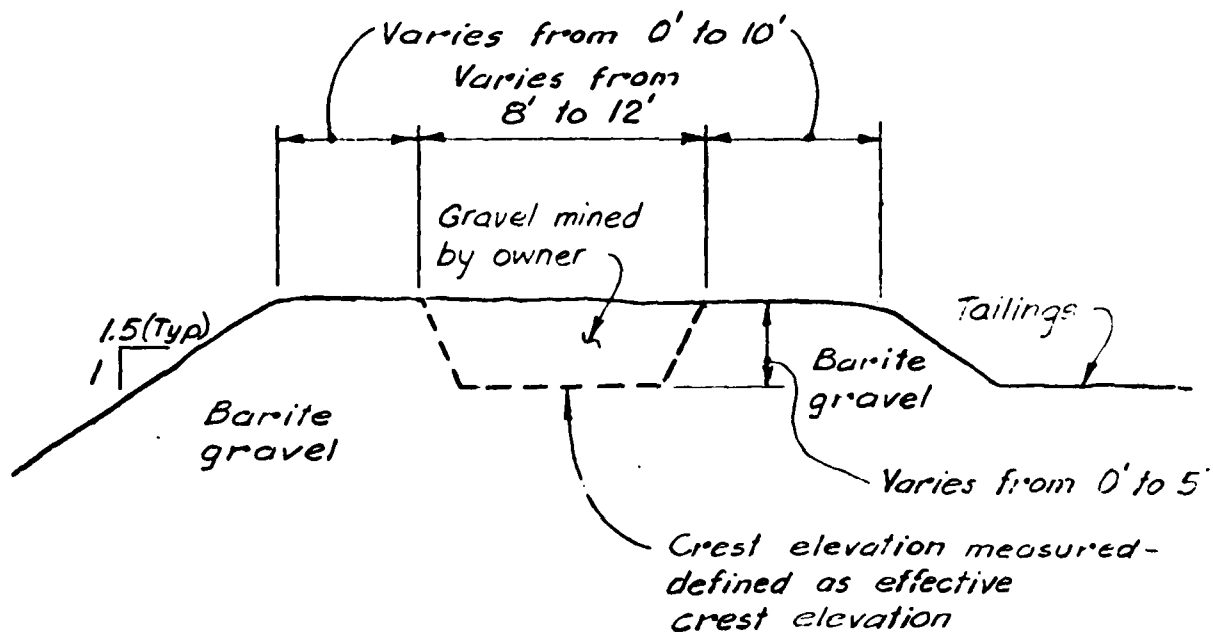
CONSULTING ENGINEERS
INTERNATIONAL ENGINEERING COMPANY, INC.
A CORPORATION INCORPORATED IN CALIFORNIA
220 MONTGOMERY STREET SAN FRANCISCO CALIFORNIA 94104

DESIGNED BY W. J. G. INSPECTED BY W. J. G.
DRAWN BY W. J. G. RE-CHECKED BY W. J. G.
CHECKED BY W. J. G. APPROVED BY W. J. G.


DATE

DRAWING NO.

PLATE 6



CREST DETAIL
 Typical where gravel is mined on dam crest

U.S. CORPS OF ENGINEERS, ST. LOUIS DIST.	
PHASE I INSPECTION OF DAMS	
RACOLA TAILINGS DAM ID. NO. 30475	
CREST DETAIL	
 CONSULTING ENGINEERS INTERNATIONAL ENGINEERING COMPANY, INC. <small>A MEMBER OF THE ENGINEERING SOCIETY OF AMERICA</small> 220 MONTGOMERY STREET, SAN FRANCISCO, CALIFORNIA 94104	
DESIGNED BY _____ DRAWN BY <i>A.C.</i> CHECKED BY _____ IN CHARGE _____	PROJECT _____ NO. _____ DATE _____ PLATE 7

PHOTOGRAPH RECORD

RACOLA TAILINGS DAM - I.D. NO. 30475

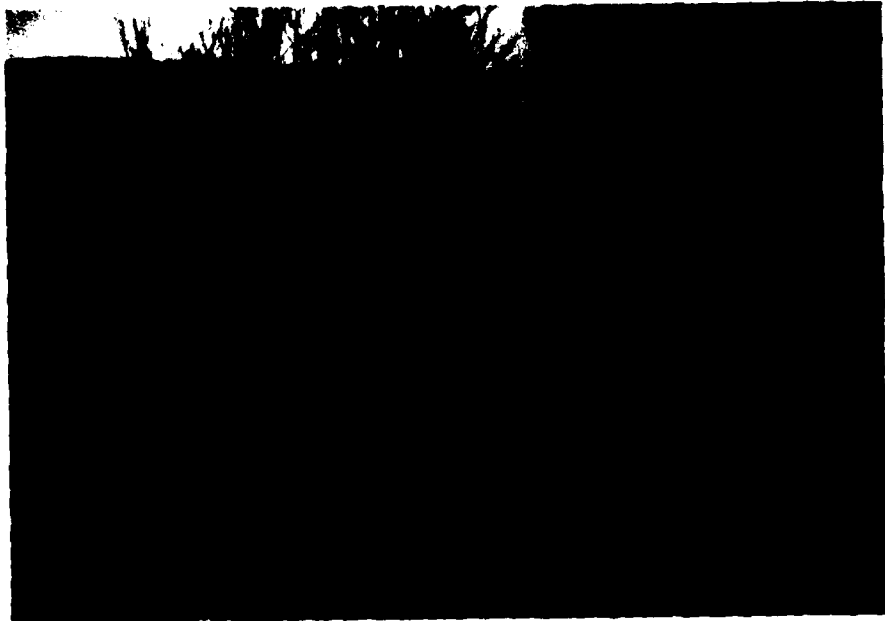
<u>Photo No.</u>	<u>Description</u>
1	View of downstream slope from west side of dam looking north. Note trees buried from enlargement.
2	View of ponded seepage at dam toe, Station 30+00. Note evidence of recent gravel mining at toe.
3	Spring at dam toe near Station 20+89.
4	Intake of 8" steel pipe shown in foreground. Note vegetation on surface of tailings pond and water surface.
5	Intake of 6" steel pipe.
6	Discharge points for 6" pipe (upper) and 8" pipe (lower).
7	8" pipe exposed in embankment Station 28+70. Note embankment materials and evidence of lift thickness used for the dam enlargements. This pipe was exposed due to mining of gravel from the toe.
8	View of abandoned 12" pipe near Station 1+00.



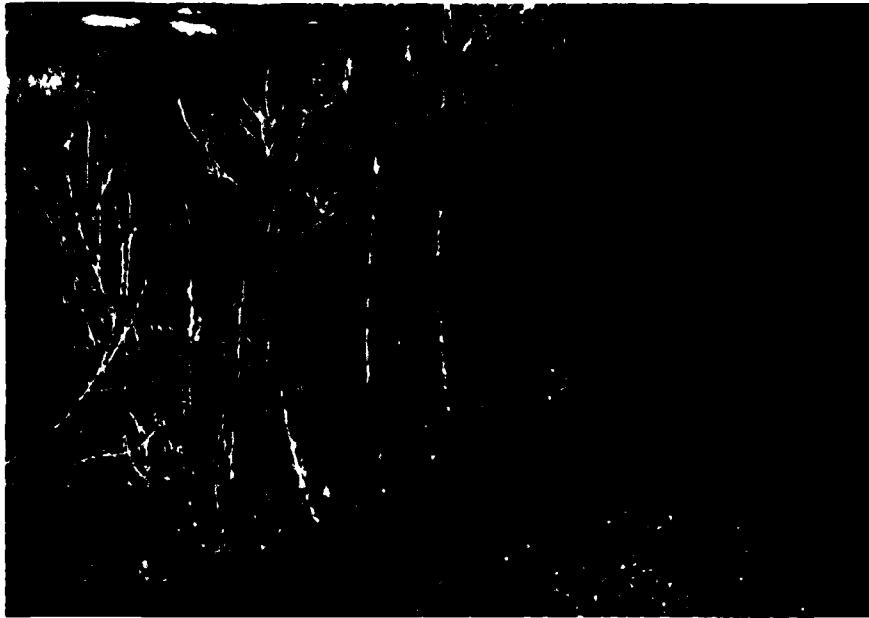
2



3



4



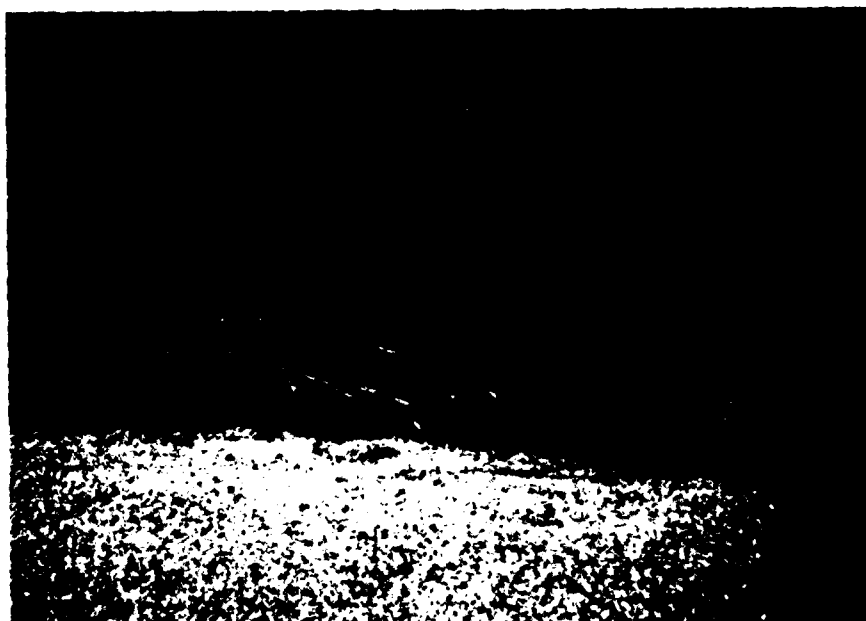
5



6



7



8

